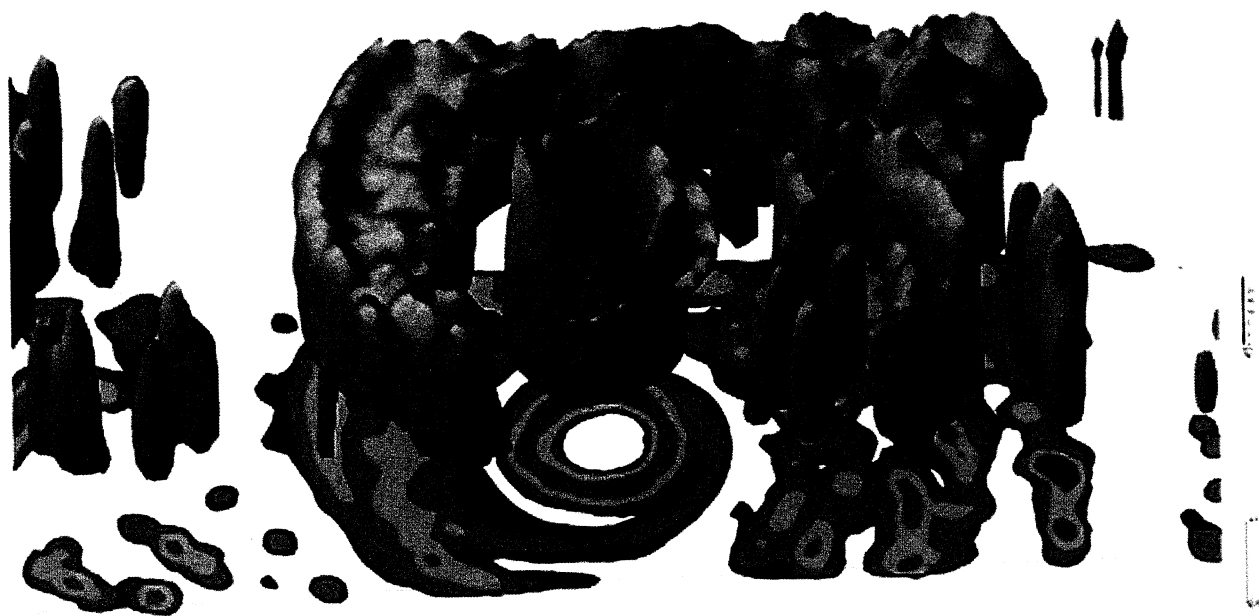


Global Change Data Center

Mission, Organization, Major Activities, and 2001 Highlights

January 2002



National Aeronautics and
Space Administration

Goddard Space Flight Center

Cover: Hurrican Floyd's 3-dimensional structure and intensity of rainfall as seen on TSDIS Orbitviewer.

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1. INTRODUCTION

Rapid, efficient access to Earth sciences data is fundamental to the Nation's efforts to understand the effects of global environmental changes and their implications for public policy. It becomes a bigger challenge in the future when data volumes increase further and missions with constellations of satellites start to appear. Demands on data storage, data access, network throughput, processing power, and database and information management are increased by orders of magnitude, while budgets remain constant and even shrink.

The Global Change Data Center's (GCDC) mission is to provide systems, data products, and information management services to maximize the availability and utility of NASA's Earth science data. The specific objectives are (1) support Earth science missions by developing and operating systems to generate, archive, and distribute data products and information; (2) develop innovative information systems for processing, archiving, accessing, visualizing and communicating Earth science data; and (3) develop value-added products and services to promote broader utilization of NASA Earth Sciences Enterprise (ESE) data and information. The ultimate product of the GCDC activities is access to data and information to support research, education and public policy.

2. PHILOSOPHY

The GCDC is an office in the Earth Sciences Directorate of the Goddard Space Flight Center (GSFC). The GCDC encompasses the design, development and management of data and information systems, the development of processing algorithms, the production of data products, the management of Earth science data archives, and the management of information system projects.

To carry out its mission and to meet the organizational objectives, GCDC has adopted a management strategy that builds on four major strategic parameters: quality, productivity, efficiency and partnerships. Within this context, GCDC has adopted the following core management concepts.

Customer driven quality

The ultimate success of the GCDC organization depends upon its ability to deliver quality products and services to a diverse user community on time and with minimum cost. All GCDC projects stress a customer focus based on an analysis of the total information system from a customer's perspective. This analysis starts with the establishment of performance-oriented requirements and ends only after delivery of a product (system, services, algorithm, data products, etc.) that satisfies the customer.

Leadership

Strong, resourceful leaders establish the direction and focus of the individual GCDC project teams. A GCDC leader is expected to be a coach, a trainer, a team builder and a role model for the project teams. Each leader must constantly assess what to change, what to change to, and how to change so that their project achieves the quality, productivity and efficiency measures needed for success.

Continuous process improvement

Most of the projects managed by GCDC are in a competitive environment where the customer has alternate choices and increasingly high expectations for services. Moreover, staff and budget constraints are a way of life and are unlikely to change in the foreseeable future. For these reasons, the continuous review and improvement of critical processes is vital to the efficient and effective delivery of quality products that meet the customer's needs.

Employee participation and development

Organizational success depends on the effective use of all the individual skills, abilities and expertise of the Government and contractor staff. GCDC projects are conducted in a cross-functional team environment that emphasizes individual accountability and creativity, encourages participation in the decision-making process, and provides rewards based on the successful achievement of project objectives. GCDC stresses the importance of employee development through training, experience, career enrichment and recognition.

Distributed management

The GCDC utilizes the strength of its leaders and employees by providing a great deal of autonomy to each project. The responsibility and accountability for decisions is delegated to the lowest level possible. The GCDC provides an overall management framework for integrated strategic planning, budgeting, scheduling, resource allocation and project assessment. Project leaders are responsible for achieving individual project goals within this overall framework.

Organizational responsiveness

Responsiveness to ever changing and evolving customer requirements requires that information systems and services be flexible and adaptable and that new systems be developed rapidly. Product cycle time is an important factor in meeting customer expectation and achieving project objectives with minimum cost. GCDC utilizes a variety of techniques to facilitate short development cycles including rapid application development and prototyping.

Design quality

The often conflicting demands of delivering the right products with high quality, on time and with shrinking budgets, emphasizes the need to build it right the first time. This is accomplished by using teams that encompass all the processes inherent to delivering an information system (design, development, test, deployment, maintenance, operations) throughout the entire development.

Strategic outlook

In order to effectively plan and manage its organizational resources, the GCDC must maintain a strategic perspective that anticipates evolving needs, and provides an orderly process for meeting those needs. This perspective is needed to provide a road map for the organization and a framework for decisions involving new business.

Objective management

To ensure that management decisions are based on facts and are timely and appropriate, projects require a flow of accurate, objective information. Open communications, objective metrics and well understood plans and schedules are critical to this process. It is important that, whenever possible, decisions be made rationally, and not in response to the crisis.

Partnership development

Partnerships with our customers are fundamental to success. The clear establishment of mutually understood requirements, the ability to meet those requirements, and the flexibility to respond to changing requirements and development problems cannot be done without close working relationships between all parties. This is particularly important in the current environment where expectations grow and budgets shrink.

Business rules

The GCDC attempts to adhere to the following rules in conducting its day-to-day business:

- anchor strategic planning to customer needs and organizational goals
- anticipate and be responsive to customer needs
- develop cost-effective systems and solutions
- utilize open and extensible system architecture
- provide value-added systems, services, skills
- reward leadership, innovation, creativity, personal responsibility
- minimize and simplify interfaces
- emphasize flexibility, modularity, reusability in system design
- maximize electronic access to information and services

3. ORGANIZATION and FACILITIES

The GCDC is organized by projects. The ongoing projects include DAO Computer System Group (CSG), Global Change Master Directory (GCMD), Goddard Earth Sciences Data Information Systems Center, Sea-viewing Wide Field-of-view Sensor (SeaWiFS) Data System, and TRMM Science Data and Information System (TSDIS). The Global Precipitation Mission data system is in a study phase, mainly conducted within the TSDIS Project.

There are 24 civil servants within GCDC, including 4 loaned from other directorates. The compositions of the GCDC Division Office and each project are as follows.

Stephen Wharton—Chief, GCDC

Kathleen Fontain

Catherine Corlan

Richard Kiang—Group Leader

Gary Wolford

DAO Computer System

Gi-Kong Kim—Manager

Global Change Master Directory

Lola Olsen—Manager

Janine Pollack

Goddard Earth Science Data & Information Systems Center

Steven Kempler (Code 586)—Manager

Gary Alcott (Code 581)

Eunice Eng (Code 586)

Christopher Lynnes

Robert Mack

Jerry Miller (Code 586)

Long Pham

George Serafino

Peter Smith

Darnell Tabb

Bruce Vollmer

Gail Wade

SeaWiFS Data System

Gene Feldman—Manager, also SeaWiFS Project Manager

Norman Kuring

TRMM Science Data and Information System

Erich Stocker—Manager

Charles Cosner Jr.

Michael McCumber—Deputy Manager

Aside from civil servants, the GCDC work activities are supported by staff of George Mason University's Center for Earth Observing and Space Research and a number of supporting contractors. The majority of the GCDC personnel are located in Building 32. SeaWiFS Data System personnel are located in Building 28.

4. OUR WORK and ITS PLACE in NASA's MISSION

The Global Change Data Center provides an essential interface to the scientific community and to the public through its data service, publications, presentations, Web pages, collaborations, and conferences. The data, data products, and associated services provided by the GCDC's various data systems directly support NASA's mission: to understand and protect our home planet; to explore the universe and search for life; to inspire the next generation of explorers,...as only NASA can. We help understand and protect our home planet by providing the data and data services necessary to understanding the Earth's system and its response to natural and human-induced changes. Our computing technologies and collaborations listed later in this document help our users improve the quality of life and create a more secure world. And we are helping to inspire the next generation of explorers by providing educational material to help motivate students, inspire teachers, and improve our Nation's scientific literacy.

The mission of the Earth Science Enterprise takes a three-pronged approach. With a science strategy, an applications strategy, and a technology strategy, the ESE seeks to develop a scientific understanding of the Earth system and its response to natural and human-induced changes to enable improved prediction of climate, weather, and natural hazards for present and future generations. This approach provides data and information necessary to answer a fundamental question: How is the Earth changing and what are the consequences for life on Earth?

The many examples that follow illustrate the GCDC's commitment to do data collection, processing, dissemination, and modeling as only NASA can.

5. MAJOR ACTIVITIES AND HIGHLIGHTS IN 2001

DAO COMPUTER SYSTEM GROUP

In accordance with a partnership agreement between 902/Global Change Data Center and 910/Laboratory for Earth Atmospheres, Gi-Kong Kim of 902 has been leading the Computing Systems Group (CSG) of 910.3/Data Assimilation Office (DAO) since September 1998. The Science Group is the other group in DAO.

The DAO CSG is responsible for the following functional areas:

- Systems engineering
- Information and configuration management including DAO ISO 2001 documents maintenance
- GEOS system testing and verification
- GEOS system operation
- GEOS operational SW development and maintenance
- GEOS data user support

System Development and Maintenance

The operational GEOS-3 system was upgraded to v3.3.9 from v3.2.5 in December 2001. The CSG made all the required changes to the preprocessing and post-processing components of the system. The CSG integrated SW for the GEOS-3 General Circulation Model (GCM) and Physical-space Statistical Analysis System (PSAS) delivered by the Science Group into the GEOS-3 system following the configuration control procedures. The CSG also performed the system verification and ran the science validation jobs. All the changes to the operational GEOS-3 system are documented by CSG. The system baseline is maintained by CSG in the version description document (VDD) for each major GEOS system upgrade.

Working closely with finite volume data assimilation system (fvDAS) developers in the DAO/Science Group, the CSG has been developing SW components such as preprocessing and post-processing functions required for the next generation system GEOS-4. CSG completed a draft version of the GEOS-4 data products file specification. CSG has been maintaining the integrated schedule for the GEOS-4 implementation. CSG also has been running and maintaining the pre-operational GEOS-4 system since April 2001.

Working with Ames Research Center/NAS and GSFC/NCCS, the two organizations that provide system management and operation of the high-end computing facilities for DAO, the CSG led the systems engineering effort to support various computing activities in system development, scientific research and system operation at DAO. At ARC/NAS, DAO has 5 64-processor SGI/O2K main compute engines and more than 200 TB of storage capacity. DAO is the primary user of a 512-processor SGI/O3K machine at GSFC/NCCS.

System Operation

The GEOS-3 system has been in operation since December 1999 producing 8 first-look and 13 late-look assimilated data products daily. The system also produces first-look forecast every day and late-look 5-day forecast every 5 days. The CSG successfully produced all the operational data products in 2001 in support of the EOS/Terra instrument teams. At the request from MODIS team for short-term reprocessed DAS products, the CSG reprocessed DAS products for October through December 2000 and provided the data products in time for the MODIS consistent year data processing.

The CSG successfully completed near-real time support for the two chemistry missions, TRACE-P and ACE-Asia, during February–May 2001. The CSG provided 2 forecast and 2 customized assimilated data products daily directly to the missions.

Highlights (2001)

The DAO/CSG continued the GEOS-3 assimilated data production operation in support of the EOS/Terra instrument teams. All the GEOS-3 daily data products—8 first-look products and 13 late-look data products—have been archived at ECS/GSFC DAAC. At the request of MODIS team, DAO reprocessed a short period of October–December 2000 using the latest operational system version and delivered the products to ECS for the MODIS consistent year data processing.

DAO successfully completed near-real time support to two chemistry missions—TRACE-P and ACE-Asia—during February–May 2001. DAO provided 2 forecast and 2 customized assimilated data products daily directly to the missions.

The DAO/CSG provided engineering support to NCCS in terms of system architectural design and user requirements for the new 512-processor SGI/O3K computer system.

GLOBAL CHANGE MASTER DIRECTORY

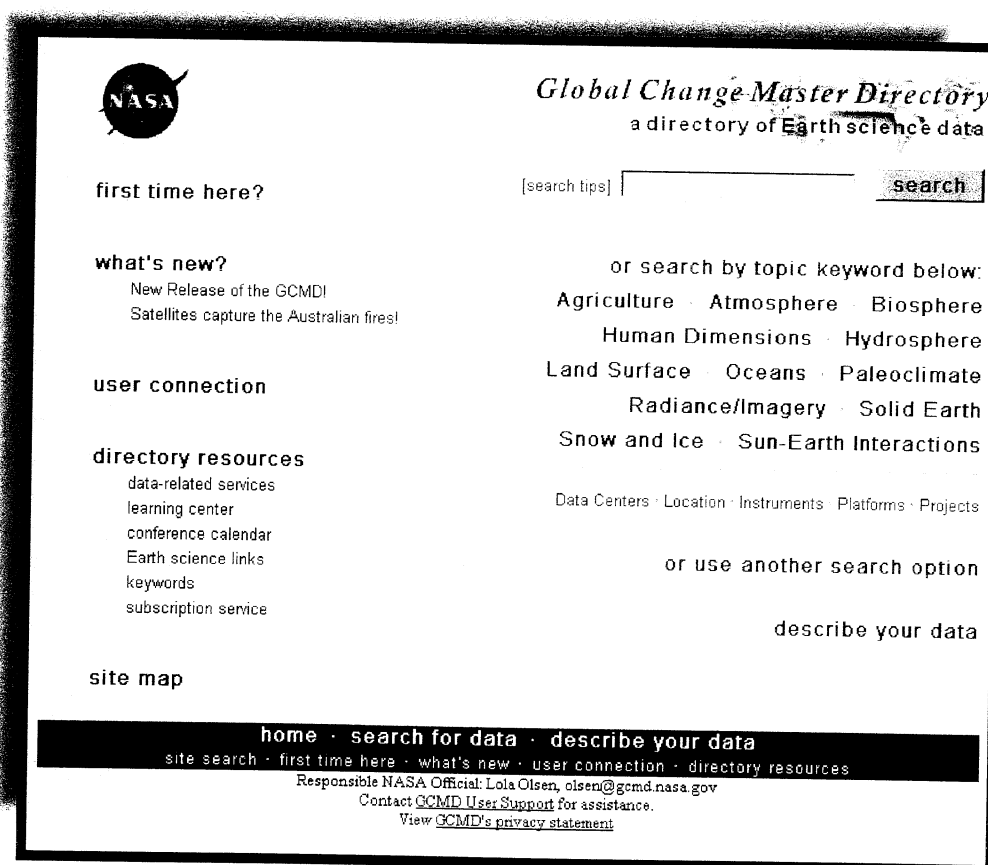


Figure 1. The main page of the Global Change Master Directory Web site.

Mission

NASA's Global Change Master Directory (GCMD) provides descriptions of Earth science data sets and services relevant to global change research. Locating and documenting all of NASA's Earth science data is a priority goal.

The GCMD's Science User Working Group (UWG) was led in 2001 by co-chairmen Dr. Bernard Minster, geophysicist at the Scripps Institution of Oceanography, and Dr. John Porter, ecologist at the University of Virginia. Dr. Elissa Levine, NASA's representative, does research in the field of soils through Goddard's Biospheric Science Branch. Other members include Dr. Jonathan Callahan, Atmospheric Chemist representing NOAA, Dr. Benno Blumenthal, oceanographer from Lamont-Doherty Earth Observatory at Columbia University, and Dr. Wendell Brown, oceanographer from the University of Massachusetts. Representing the Committee on Earth Observation Satellites (CEOS) was Andrea Buffam from the Canadian Centre for Remote Sensing.

Organization

The directory is staffed by three software developers, a database administrator, and four Earth science coordinators (one coordinator is supported by USGS's Biological Resources Division), and the Project Manager. The science coordinators are primarily responsible for the Earth science data sets related to the Biosphere and Land Surface; Oceans and the Hydrosphere; Solid Earth and the Cryosphere; Solar-Terrestrial Interactions and Radiance/Imagery; Agriculture and Human Dimensions; and the Atmosphere and Paleoclimate.

Facility

The GCMD facility is located at the Goddard Space Flight Center. The primary computing resources consist of a "proxy" computer accessible as <http://globalchange.nasa.gov>. This computer routes users to one of two operational computers, so that one is always available for access when the other needs maintenance or requires the installation of upgrades. The two operational computers are a UNIX-based Sun 3500 and an SGI Origin 200. Another computer serves the Committee on Earth Observation Satellites' (CEOS) International Directory Network (IDN), permitting access and communication with the international partners through the use of the Zen of Object Publishing Enterprise (ZOPE) software. A Sun workstation resides at the contractor's location to ease the network burden, while serving as the development platform.

System Development

At the end of 2001, the latest version of the directory software, MD8, was released to the public. The GCMD software is now completely written in Java and supports XML document types. It is a three-tier, object-oriented architecture providing lightweight clients access through Remote Method Invocation (RMI). An internal XML-based Query Language supports a rich set of queries, and an Open-API for querying to retrieve data sets using HTTPD protocol is now available. Users are offered a controlled keyword and/or a free-text search. New capabilities now exist for multiple refinements, refinement counts, customization, and cross-linking. The controlled keyword search offers users a level of quality control through XML and the database. The controlled vocabulary provides additional value by helping to normalize and standardize searches. This advantage is subsequently carried over to the free-text search. The free-text search is Z39.50 compliant and serves NASA's data set entries through the National Spatial Data Infrastructure's (NSDI) Federal Geographic Data Committee's (FGDC) Clearinghouse.

The new MD8 system has streamlined the flow of metadata within the database and among the contributing Committee on Earth Observation Satellites' (CEOS) International Directory Network (IDN) partners through its object-oriented scheme and the use of XML. The stage is now set for the introduction of Local Database Agents (LDAs), which will promote distributed input.

The software and database were modified and adapted to offer a similar search capability for Earth science-related services. This extension to the GCMD was supported through the Earth Science Technology Office (ESTO). A full report is available on request.

Operations and Maintenance

The GCMD now accommodates distributed input by any site or person hosting the MD8 Operations Client. Hosting the client allows direct input into GCMD's database and therefore immediate access by the user community to new entries. Full operations for loading, extracting, and quality-controlling database entries are available.

Content maintenance is considered ongoing through the Operations facility, as content is updated and expanded. Software maintenance is performed through the Concurrent Versioning System (CVS), a dominant, open-source network-transparent version control system that provides a central repository where developers can access/modify the operational code or a development branch.

Highlights (2001)

The directory now offers more than 10,400 Earth science metadata entries and more than 220 Earth science-related services entries. The data set descriptions have been contributed by more than 1300 data centers, Government agencies, universities, research institutions, and private researchers around the world. Usage averages nearly 20,000 unique users per month.

The Home Page was redesigned with a new site map and search tools for easier navigation of the Web site. A new "tabbed" layout for easier navigation of the data set and service entries now includes an update tab for immediate access to authoring tools for modifying or adding to an existing description.

A "User Connection" option on the GCMD's Home Page was developed for better communications with the users. This option includes access to the subscription service, user support and feedback, and to the "Interoperability Forum." The Interoperability Forum provides the venue for discussing modifications and additions to the database structure and future plans.

New "Builder" authoring tools were made available for both data sets (DIFs) and Earth science-related services (SERFs) that allow entries to be easily loaded into the database. These improved and easy-to-use tools are now welcoming many new unsolicited data set descriptions.

The Global Change Conference Calendar, maintained by the GCMD saw increased frequency of use by Earth science groups for planning upcoming meetings.

GCMD "portals" were also developed during the year for organizations to host a site offering the metadata they contribute to the GCMD as a virtual subset of the full directory from customized "portals"—designed

and maintained by the directory staff. Portals were made available for the following groups: the Joint Committee on Antarctic Data Management (JCADM), the Distributed Oceanographic Data System (DODS), the Rosenstiel School of Marine and Atmospheric Science (RSMAS), the Federation of Earth Science Information Partners (ESIPs), the Global Observation of Forest Cover (GOFC) project, the World Data Centers (WDCs), the Global Ocean Ecosystems Dynamics program (GLOBEC), and the Global Observing System Information Center (GOSIC)—made up of data from the Global Terrestrial Observing System (GTOS), the Global Climate Observing System (GCOS), and the Global Ocean Observing System (GOOS).

More specifically, collaborations with the JCADM intensified with the addition of over 500 new metadata records related to the Southern Ocean and Antarctic regions. A joint JCADM-GCMD presentation was given at the Geological Society of America (GSA) meeting in November.

The portal for the Global Observation of Forest Cover (GOFC) Web Mapping Testbed (WMT) highlighted a demonstration to the plenary Committee on Earth Observation Satellites (CEOS) in Japan in November.

GODDARD EARTH SCIENCES DATA and INFORMATION SYSTEMS CENTER

Organization, Mission and Strategy

The Goddard Earth Sciences (GES) Data and Information Systems Center (DISC) is a part of the Global Change Data Center (GCDC), GSFC Code 902. The DISC provides data and services for global change research and education.

The GES DISC mission is to maximize the investment of NASA's Earth Science Enterprise by providing data and services that enable people to realize the scientific, educational, and application potential of global climate data.

As a source of information for atmospheric, hydrologic, land biosphere and ocean color data, the GES DISC facilitates the study of natural and human processes that influence Earth's climate, by processing, archiving, distributing, and providing user and value added data management services.

The DISC is divided into two groups:

1. The Distributed Active Archive Center (DAAC). Responsible for the execution of heritage DAAC data management functions, including data ingest, archive, production, distribution, management, and user services; system engineering; data support; science software integration, and development of DAAC unique extensions.

The DAAC is comprised of

- ◇ Version 0 (V0). Developed by GES DAAC personnel to support data originating prior to 1998.
- ◇ Version 1 (V1). Developed by GES DAAC personnel to support data originating from TRMM, starting November, 1997.
- ◇ Version 2 (V2 aka ECS). Developed by the ESDIS Project to support Terra, launched December 1999, and Aqua, launched May 2002.

The GES DAACs goal is to efficiently and cost-effectively ingest, produce, archive, and distribute Earth Science data and information, related to hydrology, ocean biology, atmospheric dynamics and chemistry, and land biosphere, and perform the data management functions and services that maximize the use and usefulness of this data and information.

2. The Products and Services Cooperative (PSC or the CO-OP). Responsible for new products and services in cooperation with, and support of, the Earth science data community, including development and deployment of products and data management services for new projects; development of value-added products such as data management and manipulation tools that can be reused; new technology development; new project initiatives; product reuse.

The GES PSC uses the following criteria to take on new work:

- ◇ The new work must be useful to a group of users
- ◇ The new work must facilitate science (e.g., Add value to existing products or services)
- ◇ The new work must provide a means to improve DISC and other data center data management facilities, on the individual and data center levels

The GES PSC's goal is to develop, in complete collaboration with individuals being served, keep inventory, and provide, data management products and services in response to the changing data management requirements of the Earth science community, and the development of new applications.

Figure 2 illustrates the DISC organizations.

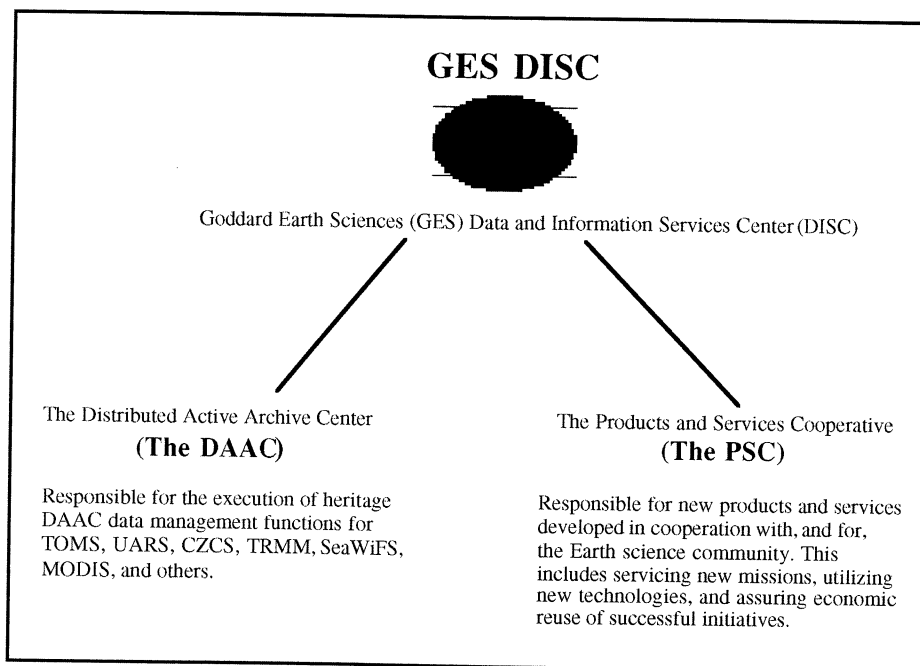


Figure 2. GES DISC Organization Definitions.

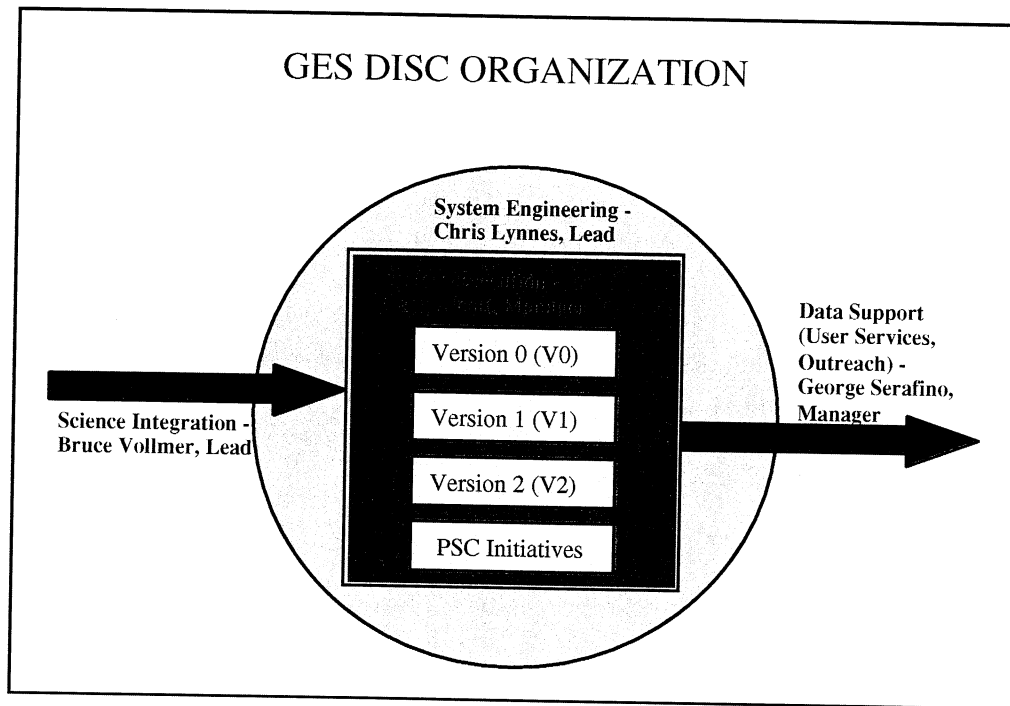


Figure 3. GES DISC Organization.

Within the GES DISC organization, four highly dependent components exist, each addressing a vital part of the GES DISC:

- Engineering and System Development
- System Execution
- Data Support
- Science Integration

Figure 3 depicts the relationship between the DISC groups.

The GES DISC strategy is built upon balancing two opposing drivers: Maintaining a high level of customer services and performing appropriate functions within budgetary constraints. Thus, the GES DISC utilizes the following strategies to strive toward this balance:

- Engage Scientists
 - Communications must be frequent
 - Dedicated points of contact to gather/provide information are identified
- Build economically
 - Look for reuse, ways to save funds
 - Willing to take calculated risks; otherwise low risk
 - But also, build to integrate new technologies
- Engage employees
 - Ensure that employees realize the value of their contributions
 - Treat all employees equally; maintain a badgeless environment; work around distracting contractual issues

In November 2000, the GES DISC initiated and hosted its first reinstated DAAC User Working Group (UWG), and has had two additional meetings since then. The purpose of the GES DAAC UWG is to acquire from GES DAAC stakeholders guidance and recommendations that would better prepare the GES DAAC to serve the Earth science community in the future, in accordance with DAAC resources.

The GES DAAC UWG is chartered to:

- Understand the GES DAACs philosophy, operating environment, mission, direction, constraints, issues, choices, etc.
- Provide clear, objective recommendations on the data management issues facing the GES DAAC
- Advocate activities (internal and external to the GES DAAC) that are consistent with the GES DAAC goals, to facilitate science
- Remain engaged with GES DAAC activities and issues throughout the year so as to maximize their effectiveness, and be better prepared for consultation.

UWG Meeting Objectives are to

- Understand the GES DAAC philosophy, tasks, priorities, contributions, and constraints
- Provide feedback on the GES DAAC strategies that are based on NASA ESE direction
- Evaluate GES DAAC issues and provide a user perspective to GES DAAC strategies that address these issues
- Provide recommendations that support the GES DAACs goal to facilitate science consideration given to science, enterprise, and technology directions, and resource constraints.

The desired outcomes of the UWG Meeting include

- Recommendations that would best serve the GES DAAC community
- Consultation on policy development (e.g., reprocessing, distribution)
- Acquire community opinion/advice on billing and accounting, operations, etc.
- Acquire community feedback on the functionality and directions of the GES DAAC

Dataset Holdings

The GES DISC holds remotes sensing data for the following Earth science disciplines:

- Atmospheric Chemistry
- Atmospheric Dynamics
- Hydrology
- Interdisciplinary Studies
- Ocean Color
- Land Biosphere

The following figures illustrate discipline specific imagery and data sources that are accessible from the GES DISC data holdings.

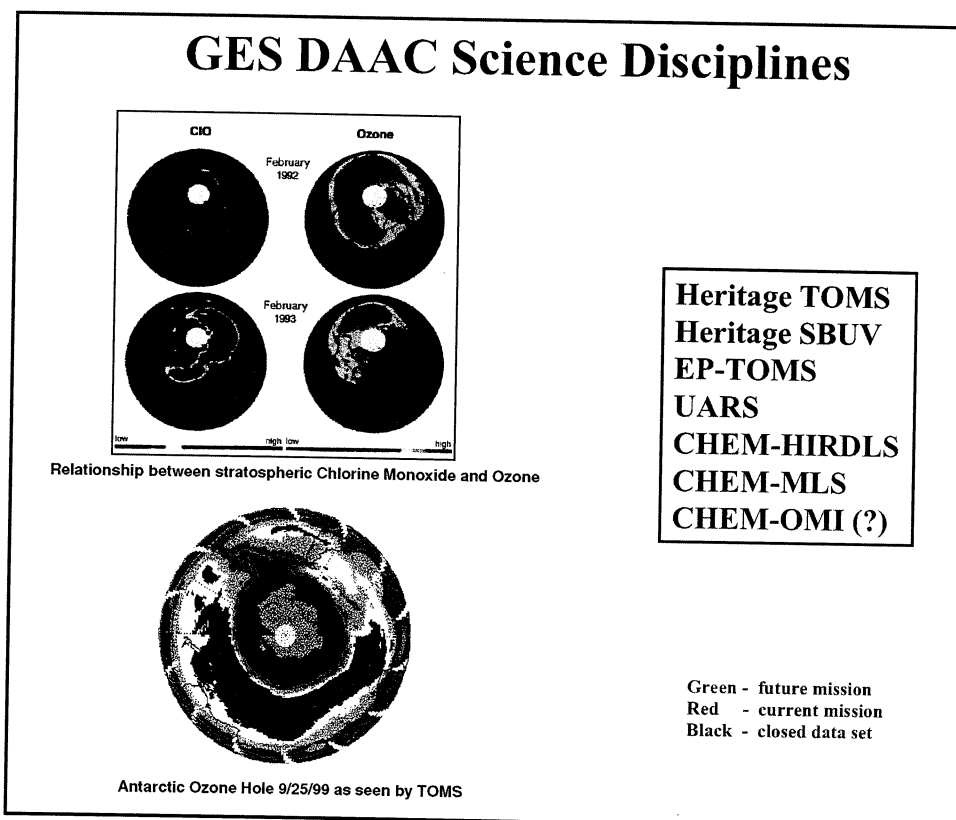


Figure 4. GES DAAC Atmospheric Chemistry Datasets.

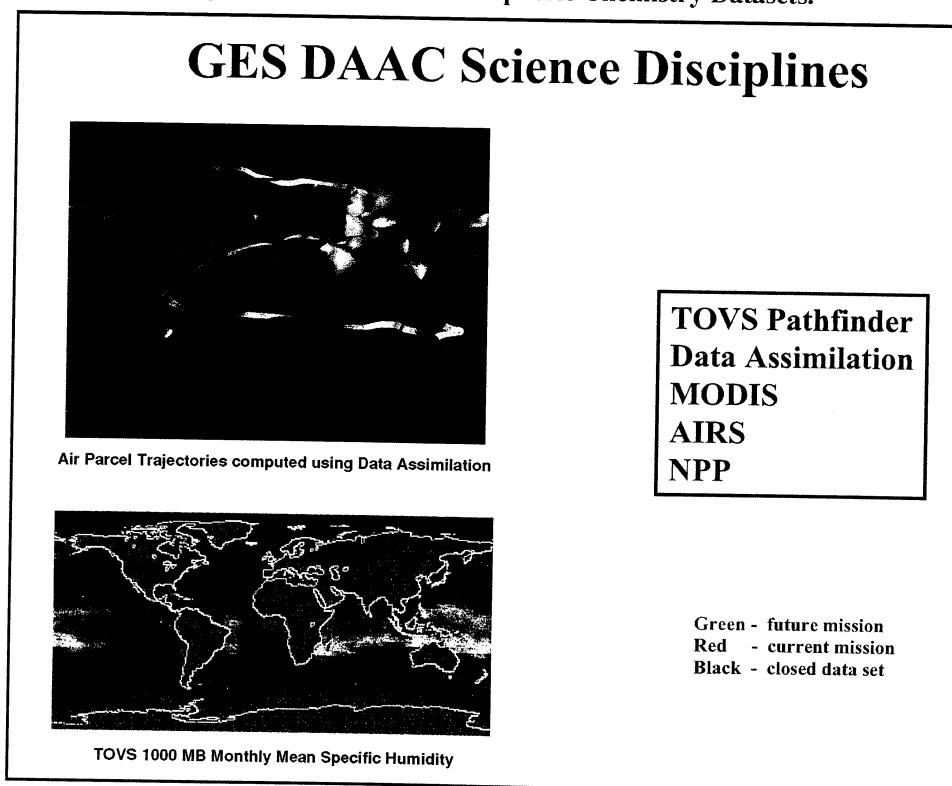


Figure 5. GES DAAC Atmospheric Dynamics Datasets.

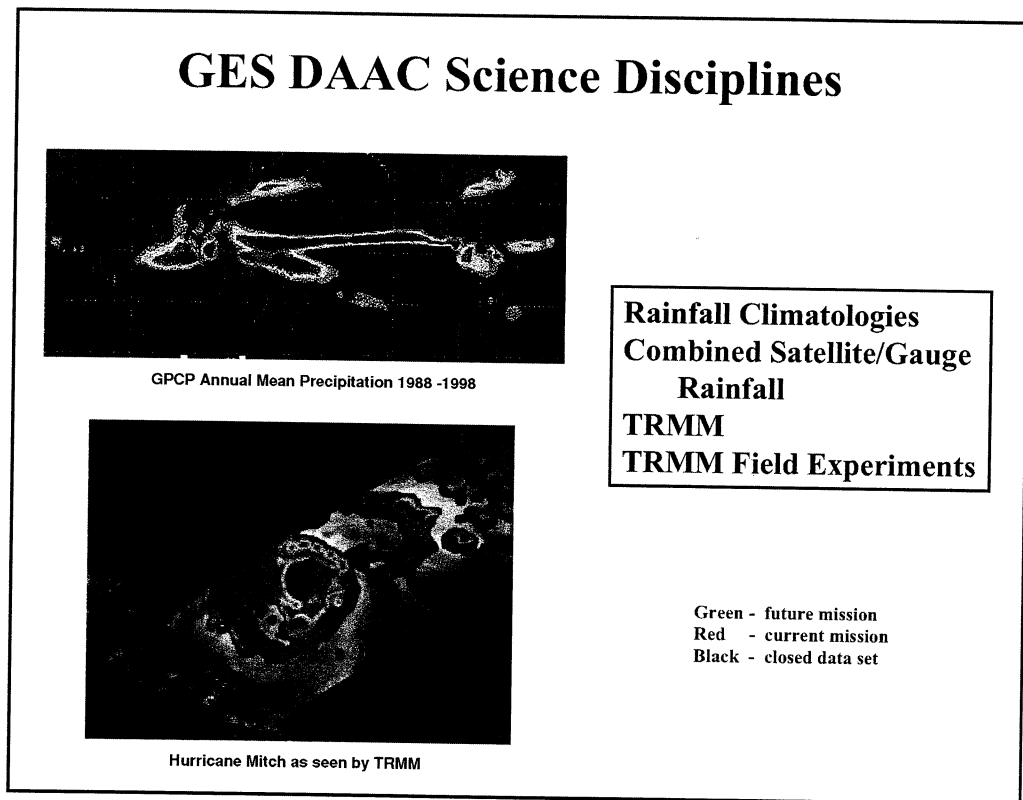


Figure 6. GES DAAC Hydrologic Datasets.

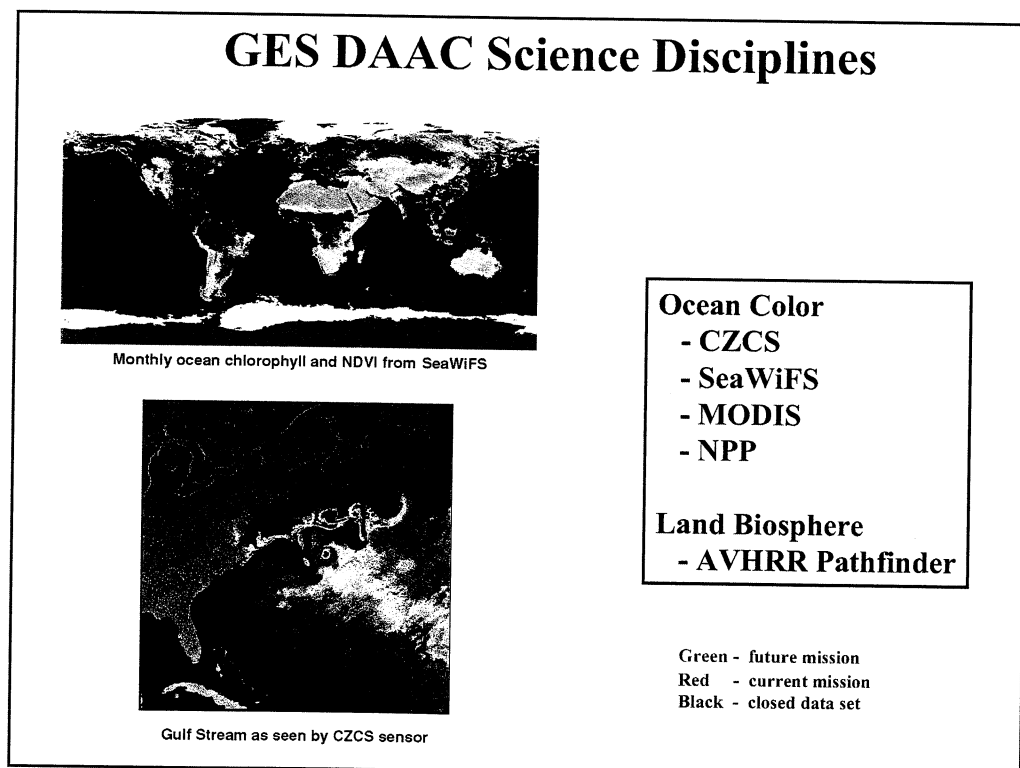


Figure 7. GES DAAC Ocean Color and Global Biosphere Datasets.

Data Systems and Tool Holdings

The GES DISC is not only the archive for the Earth science data just described, but it provides the kinds of services and tools that further facilitate the usability and accessibility of these data. The following systems and tools were implemented by the GES DISC, often enabling EOSDIS functionality which would otherwise not be available:

- The Version 0, Version 1, and Version 2 (ECS) data management systems
- Simple Scalable Script-based Science Processor (S4P) data production system
- Web-based Hierarchical Ordering Mechanism (WHOM) interface
- Subsetting/subsampling and format conversion tools
- Data mining environment

Major Activities and Highlights (2001)

The GES DISC major activities and highlights center around the organization's central operations and efforts to improve data system operability, efficiency, data accessibility and data usability. These activities range from implementing new data management technologies, to developing value-added products and tools, to exploring advanced data center paradigms for providing user services for the sake of facilitating data usage for research and applications. The following 2001 GES DISC highlights, and their impacts, are organized by DISC group.

System Engineering

The GES DISC Engineering staff is primarily responsible for maintaining the integrity, currency, and usability of GES DISC operational systems, as well as taking on many new innovative activities which add very worthwhile functions to the GES DISC arsenal of data management capabilities. Highlights include

Development of the Simple Scalable Script-based Science Processing System (S4P)

S4P was self-initiated and developed by the GES DISC as an alternative data processing engine for new missions needing a simple way to execute data-driven science algorithms. S4P lends itself to be easily portable to the DISC's main processing system, as well as scientist site data processing environments. S4P's success is reflected in the fact that it has been reused 4 times, including integration into ECS, and has provided a capability previously unavailable to various projects. These include MODIS Direct Broadcast, MODIS processing and reprocessing, and one of the first MODIS Quick Response processing systems. The latter was directly responsible for quickly providing data for the successful APEX field experiment in Japan, and the Northwest forest fires. Data would be unavailable in a timely manner for any of these projects without the availability of S4P.

A related major highlight deserving additional attention, is the use of S4P for MODIS Direct Broadcast. The packaged MODIS level 1/ DISC S4P software has been distributed to over 20 potential Direct Broadcast sites.

Data Mining Environment Development

Christopher Lynnes and Robert Mack submitted a book chapter entitled “Knowledge Discovery in Databases (KDD) Services at the Goddard Earth Sciences Distributed Active Archive Center” that discusses the data mining environment developed at the GES DISC. With scientist-provided science software, the GES DISC completed the first TRMM Data Mining campaign with great success. Three science groups participated with a total of 6 mining algorithms. The first mining campaign resulted in data distribution reductions ranging from 37 to 1, to 4 to 1 depending on the algorithm, and grounds for further study. A second data mining campaign was subsequently initiated.

As a result of the promise of data mining in the TRMM environment, the GES DISC began the development of a MODIS Near Archive Data Mining environment for the purpose of acquiring data reduction algorithms to reduce the voluminous MODIS data distribution.

Implementation of Advanced Data Access Methods

GES DISC data access was enhanced in the following ways:

- Long Pham completed the integration of the Distributed Oceanographic Data System (DODS) into the DISC to further broaden the accessibility of GES DISC data
- Promoted Web Mapping Server to operations, allowing OpenGIS client access to select DISC datasets
- Developed prototype to export Version 0/ Version 1 metadata in XML to EOSDIS Clearinghouse (ECHO)

These all make use of the latest trends in technology and are beginning to make positive impacts on data access.

System Execution

The System Execution team is responsible for the operations of the GES DISC active archive systems, ensuring that the system produces, archives and distributes data properly, and the system is operating optimally. Highlights include—

Procedural Accomplishments

In conjunction with the MODIS Science Team, the GES DISC began and successfully completed the MODIS L1 data reprocessing, resulting in 14 months of validated Level 1 data (and counting). In addition, almost all MODIS Level 0, Level 1, and higher level Atmospheric and Ocean data products were publicly released, as well as Level 1B Browse Product.

All ECS procedures (planned and unplanned) have been documented during this period, allowing the operation staff to perform more efficiently, more independently, and with greater responsibility.

Regarding operational readiness for Aqua, the GES DISC successfully deployed ECS System Release 5B07, followed by ECS System Releases 6A04 and 6A05, into operations. In addition, the GES DISC successfully supported four Aqua mission operations tests (MOSS tests).

Data Archive Accomplishments

In archiving over 500 Tbytes of data in ECS, thus far, the GES DISC—

- Processed >280 days of MODIS Collection 1 data
- Preprocessed and processed more than a Complete Year of MODIS Collection 3 data, starting November 2000
- Routinely ingested data from the MODIS PI Processing System (MODAPS)
- Processed and distributed special requests of data in support of major field campaigns, such as SAFARI
- Additional hardware installed in preparations for AIRS processing
- Newer technology tape drives (9940's) installed

Data Support

The Data Support Team (DST) consists of science- and engineer-trained people who support GES DISC data. Each member of the DST specializes in GES DISC discipline specific data holdings. DST members not only provide user and data support, but they also are tasked to develop value-added products, requiring small efforts. Another major task of the Data Support group is to acquire and make available NOAA NCEP ancillary data products to all Earth Science Enterprise DAACs. Highlights include—

Developing Value Added Products, Tools and Documentation

The GES DISC DST developed additional extensions to the EOSDIS Core System (ECS) to enhance operability (e.g., Metrics tools, data manipulation tools, user requested interfaces), essential for reporting progress and system efficiency. In addition, the team developed software to create value-added products for TRMM, MODIS, and AIRS (being tested), such as regional subsetting, on-demand subsetting, subsampling, data conversion to GIS and binary formats, and data mining. These tools address two user-specified data access issues: the large minimum volume that can be shipped and the need to provide data in alternative formats.

The release of MODIS products, now accessible and being used by the public, is greatly aided by extensive search and guide documentation prepared by the GES DISC DST, meeting the standards of EOSDIS and satisfaction of the users.

The DST also implemented a prototype version of the On-line Analysis Software (OASIS) system for use with V0 atmospheric dynamics data sets to provide basic data manipulation, visualization and analysis capabilities to the user prior to ordering. Developed in response to user feedback, this tool takes advantage of technology that now allows such tools to be implemented

Recognizing the diversity of data access protocols (again, one size does not fit all) and in response to user requests, the GES DISC is addressing the needs of its users by developing the Universal Data Reduction Server to serve data using various protocols.

Many new value-added data products are available through the GES DISC including—

- New global merged IR product consisting of brightness temperature measurements from GOES, Meteosat and GMS geostationary satellites, in support of GSFC Code 912

- Two new ancillary data sets implemented in support of Data Assimilation System processing
- New SeaWiFS Evaluation product
- GPROF 6.0 Gridded Orbit-By-Orbit Precipitation Data Set, providing instantaneous, gridded values of precipitation totals based on SSM/I data
- SeaWiFS External Browser completed; DISC has received about 200 advance requests for this product
- 4 new TRMM GV data products processed by the University of Washington and delivered regularly via TSDIS

Science Support and Collaborations

The GES DISC DST Provided 24 x 7 service for ancillary data acquisition for the DAO in support of the Ultra Long Duration Balloon (ULDB) experiment. The importance of this experiment was recognized as a way for the GES DISC to support the gaining popularity of DAO data, and the interests of a NASA ESE commitment.

During the summer of 2001, the GES DISC DST responded to the TRMM orbit boost by implementing data management changes (e.g., new documentation, updated access and display tools, etc.) in a timely fashion. Doing so, by quickly reprioritizing its workload, the GES DISC DST was able to ensure zero impact to normal TRMM data management operations, including the user accessibility to TRMM data.

The GES DISC has engaged collaborators as Remote Sensing Information Partner (RSIPs). These are secondary data distribution sites of GES DISC data, whose purpose is to acquire DISC products, develop value-added products, distribute these products to a wider community (thus enhancing data distribution). Highlights of this activity include—

- Developing a prototype Geographic Information Systems (GIS) data product for MODIS surface reflectance data in support of the Rutgers RSIP
- Hosting a visit from the UNM/EDAC personnel to consolidate plans for future operation of this RSIP node
- TRMM products routinely flowing to University of New Mexico (UNM) RSIP and preparing for redistribution
- Continuing to work closely with George Mason University on ESE Federation activities
- Routinely sending MODIS Oceans data to JPL
- Holding a training session for RSIPs describing how the GES DISC services its data

In addition, the Alpha version of an Environment and Health (E&H) data system designed to facilitate discovery, access and use of Earth science data for health-related research activities was demonstrated. The infrastructure developed successfully proved the feasibility of specialized discipline-specific data systems.

The GES DISC was very fortunate to be able to provide data management inputs to four ESSP Step 1 proposals regarding production, archive and distribution support of these missions at the DISC. Not only do these collaborations provide the opportunity to support new science missions, but they also show that the GES DISC is recognized for providing data management experience, as well as inexpensive and reliable solutions.

Responding to Data Support Needs

Prior to the delivery of the ECS user interface, the GES DISC successfully adapted and reused the Version 0/Version 1 Web Hierarchical Ordering Mechanism (WHOM) as an interface to accessing MODIS data. The WHOM reuse has proven not only to be a user friendly alternative for accessing MODIS data, but a reliable backup to the EOSDIS interface (EOSDIS Data Gateway or EDG), and currently a more popular means to access MODIS data at the GES DISC.

The GES DISC provides a full suite of user services, from telephone and e-mail support to the recently implemented MODIS Frequently Asked Questions Web page. The GES DISC fully understands the various levels of service that may be provided, and strives for the highest affordable level. In fact, a preliminary version of a Data Center Levels of Service model had been circulated by the GES DISC.

Science Integration

The GES DISC's Science Integration group ensures that science software and associated documentation is integrated into the DISC data systems.

Taking science software from one development environment and integrating and testing it into the GES DISC has proven to be an important, yet precise effort. Not only is MODIS Level 1 science software integrated, but now the GES DISC has an environment to integrate science-developed software to reduce data volumes distributed. The GES DISC Science Integration group has improved the efficiency of the MODIS Science Software Integration and Test (SSIT) process, thereby more easily accommodating new and sudden changes to science software (a.k.a. PGEs) resulting from instrumentation changes, necessary calibration Look up Tables (LUTs) changes, and Aqua MODIS PGEs, with little impact to the science team. Utilizing these process improvements, all MODIS Level 1 Collection 1, and now Collection 3 science software, had been integrated and tested at the DISC, producing validated MODIS Level 1 data.

GES DISC-wide Highlights

Activities at the GES DISC initiated in 2001 include—

- NPOESS Preparatory Project (NPP)—The GES DISC was selected as the site for the NPP Science Data Segment (SDS) Operations and Data Management for selected NPP Principal Investigators. As the effort picked up, GES DISC participated in the NPP System Requirements Review (SRR) and submitted the NPP operations life cycle budget. Staffing had begun for FY02.
- Global Precipitation Mission (GPM)—The GES DISC participated in the GPM Planning Workshop and submitted a technical and cost proposal for data system.
- Earth Sciences Enterprise Federation—As Federation Products and Services committee chair, Steve Kempler leads monthly telecons and biannual discussions towards accomplishing the following:
 - ◊ Developed and delivered a Federation Products and Services brochure
 - ◊ Completed Federation product registration in GCMD
 - ◊ Completed Products and Services inventory specifically made for the LBA Project

In addition, GES DISC personnel participated in various cluster and science applications, further facilitating the use of GES DISC data and information services to new markets. The Products and Services Chair is also a member of the Federation Executive Committee.

SeaWiFS DATA SYSTEM

Two Global Change Data Center civil servants support the SeaWiFS Project as well as the development and operations of the SeaWiFS Data System. Please refer to NASA/GSFC Laboratory of Hydrospheric Processes Annual Reports for details of SeaWiFS Data System and its operations.

TRMM SCIENCE DATA and INFORMATION SYSTEM

Organization

TSDIS is the data and information processing facility for the Tropical Rainfall Measuring Mission (TRMM). TSDIS processes data from the three TRMM satellite instruments: the Visible and Infrared Scanner (VIRS), the TRMM Microwave Imager (TMI), and the Precipitation Radar (PR). TSDIS also ingests ground validation radar data from TRMM investigators and from the TRMM Office and catalogs associated metadata information in its database. All TRMM data products are sent to the Goddard Distributed Active Archive Center (DAAC) for long-term archive. TSDIS provides data product browse and ordering support to a select group of investigators (e.g., TRMM algorithm developers, the TRMM instrument scientists, and TRMM data quality scientists). The general public accesses TRMM data through the Goddard DAAC.

TSDIS also provides science support to the TRMM algorithm developers. This support includes evaluation of algorithms in the TSDIS Integration & Test Environment (ITE) and development of data display tools.

Additional information about TSDIS activities can be found at the TSDIS website (<http://tsdis.gsfc.nasa.gov/tsdis/tsdis.html>).

Facility

The TSDIS facility is located at the Goddard Space Flight Center. The main computing resources consist of a distributed array of SGI computing platforms which are partitioned into processing streams. These streams are aligned with particular TRMM instruments and with the type of processing (i.e., initial processing or reprocessing). The system is sized to ensure that satellite data can be processed well within 24 hours of receipt for initial processing. For reprocessing, the system was originally sized to generate data products at a rate of 2 data days per day. Upgrades have significantly enhanced this capability.

HP computers are used to house the database, the automated scheduler, and Openview (monitoring software). RAID, NetApp and Unitree storage devices provide large on-line and near-line storage capabilities. These large storage capabilities are especially helpful to speed reprocessing and algorithm testing, since the starter files are resident at TSDIS and thus don't have to be retrieved through the DAAC pipeline.

A dedicated PC provides a link to the Science Data Processing Facility (SDPF), which supplies Level-0 data and ephemeris files to TSDIS. Since the SDPF is now highly automated, this link is essential for TSDIS operators to access needed files when problems occur with the SDPF server when that facility is not staffed. Upon request, TSDIS also can access files for retransmission to NASDA under these circumstances.

Another dedicated PC provides a link to the TRMM Mission Operations Center (MOC). This link is used to send instrument command requests or Quick Look data requests from the TRMM instrument scientists to the MOC.

Major Activities

Science Support

TRMM Fire Product

A TRMM fire algorithm was developed at the request of global users. This algorithm, based on data from the Visible and Infrared Scanner (VIRS) instrument, routinely produces global daily hot spot images and a monthly composite image. The fire products are available, along with source code, from the TSDIS home page (<http://tsdis.gsfc.nasa.gov/tsdis/tsdis.html>). Both near real-time and archived products (beginning in January 1998) are easily downloaded. The TRMM fire products have been used to monitor global wildfires and to study the climate variability of fires and aerosols. Users include the University Corporation for Atmospheric Research (UCAR) and the European Commission Joint Research Center (EC/JRC). From more information, contact Yimin Ji (yji@tsdis.gsfc.nasa.gov).

TRMM Mission Index

Since its launch in 1997, the Tropical Rainfall Measuring Mission (TRMM) has created a large collection of rain estimates. Over eight terabytes of orbital rain products have been produced from just the TRMM Microwave Imager (TMI) and the Precipitation Radar (PR) (algorithms 2A12 and 2A25). A new method was developed to help investigators locate data of interest in this vast dataset. This method, called the Mission Index, is an enhancement to the TSDIS Orbit Viewer, a tool for displaying TRMM standard products.

The Mission Index is designed to be used locally by an investigator on his own computer. Both the code and the Mission Index data files are available from the TSDIS Web site (<http://tsdis.gsfc.nasa.gov/orbitviewer.html>). The Mission Index data files are a low-resolution version of the original orbital data products; they have the advantage of being five orders of magnitude smaller than the orbital products and are thus easily usable.

The Mission Index is used in the following way. The investigator selects a region of interest. The Orbit Viewer dynamically creates a time series of rain in that region over an entire year [1] based on the data in a Mission Index data file. Clicking on a peak of the time series displays a low-resolution image of that day's rain [2]. The low-resolution image displays the orbit number of the full resolution file of interest. The orbit number is used to order the file from the TRMM archive [3]. The full-resolution file can then be displayed in the Orbit Viewer [5].

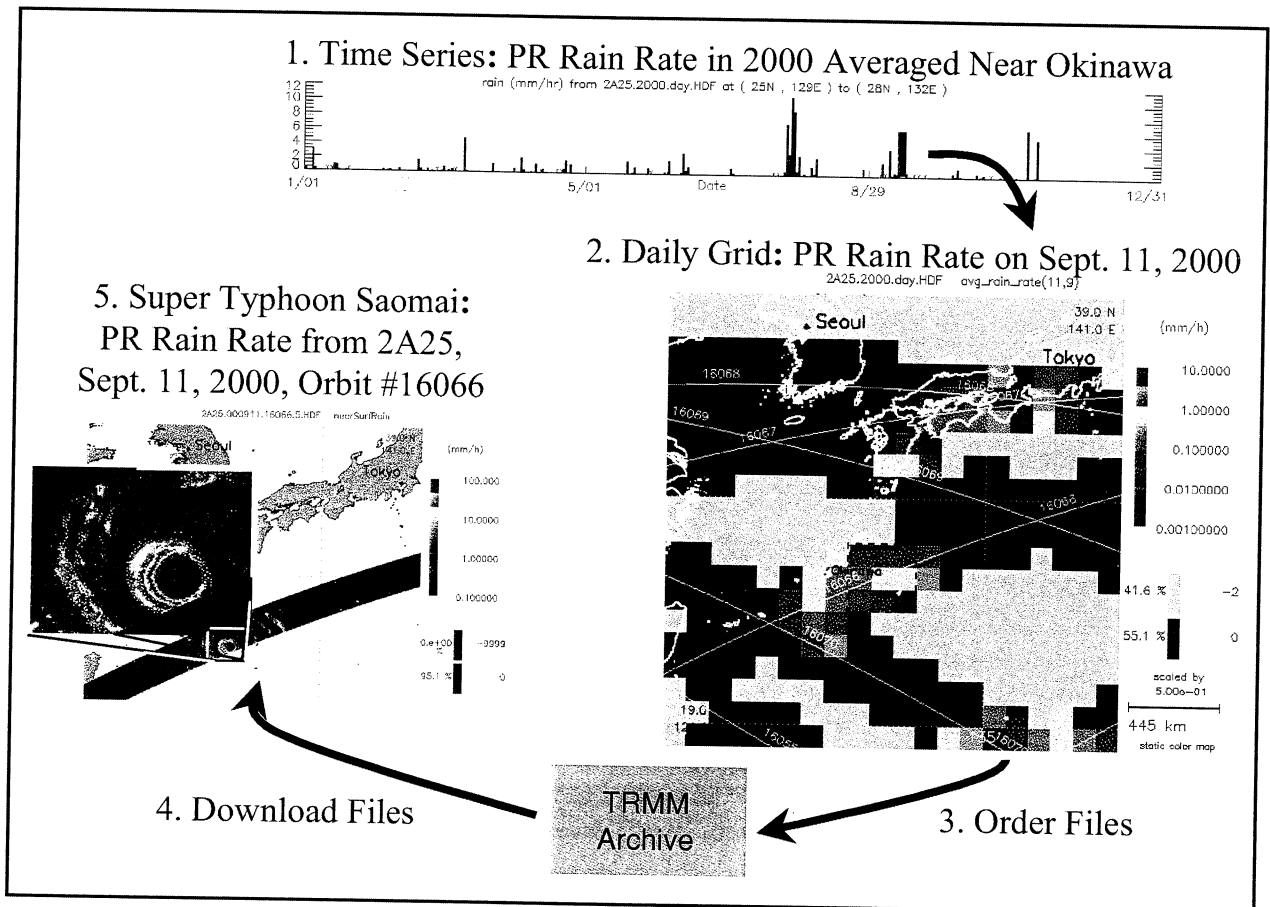


Figure 8. Graphical depiction of the process for ordering and displaying data using the TRMM Mission Index.

As investigators work with the growing data set from the TRMM satellite, their data search needs become more apparent. Responding to their requests, the Orbit Viewer serves as an evolving tool for data search and display. For more information on the TRMM Mission Index or the TRMM Orbit Viewer, contact Owen Kelley (okelley@tsdis.gsfc.nasa.gov).

Data and Information Processing

TRMM Data products were generated for the satellite instruments. In 2001, 82,206 data products were created for initial processing. The total includes some retro-processing of data to correct for errors. Each product represents a granule (i.e., 1 orbit) of data. The data products include Level-1A through Level-3B. Browse images (i.e., low-resolution images used for product ordering) and Coincident Subsetted Intermediate (CSI) products between ground sites and TRMM overpasses were also created. They are not included in the product total cited above.

No reprocessing was done in 2001.

MAJOR ACTIVITIES AND HIGHLIGHTS IN 2001

The TRMM satellite was raised near mid-year to a higher mean orbit (from 350 km to 402.5 km) to extend the mission life. The product version of the post-boost data products was altered slightly to distinguish the different characteristics (e.g., pixel size) of the data products.

Availability of the processing system was high. Total system availability for the year was 97.52%. Of the 2.48% downtime experienced, 0.45% was unplanned. The remaining downtime, 2.03%, was scheduled, including system upgrades and routine maintenance.

The TRMM Office at GSFC assumed responsibility for generating the radar products for the four primary TRMM Ground Validation sites (Kwajalein Atoll, Marshall Islands; Houston, Texas; Melbourne, Florida; and Darwin, Australia). These data products were ingested into TSDIS, whereupon browse images were created and metadata were included in the TSDIS database. Additional ground radar data products for Kwajalein Atoll were also ingested by TSDIS. These products were generated by University of Washington researchers using their own calibration algorithms, which differ from those used by the TRMM Office.

Highlights (2001)

Inter-Comparison of Relationship Between TMI and PR Rainfall Estimates

The relationship between TRMM Microwave Imager (TMI) rainfall estimates and Precipitation Radar (PR) rainfall estimates was investigated using plots of the joint probability distribution of rainfall. The motivation was to provide improvements in TMI estimates. TMI and PR rainfall estimates are similar over oceans, but not over coasts and land. TMI rain estimates are characterized by a narrow range and bimodal distribution over coasts, and they are very quantized over land (i.e., rainfall occurs at only a few values and not in between these values). Rain type also affects the relationship: the PR rainfall estimates are greater than the TMI rainfall estimates for convective rain pixels, but the reverse occurs for stratiform pixels.

This work has implications for the validation of TRMM rainfall products in the following regard. Some of the validation sites used in TRMM consist of a few small islands in mostly ocean areas. The TMI rain algorithm classifies these sites as coast, and thus produces rain estimates that are twice as large as nearby oceanic areas. By contrast, the PR algorithm estimates rainfall consistently for the islands and nearby ocean. For more information, contact John Stout (stout@tsdis.gsfc.nasa.gov).

PR Sensitivity Studies

Sensitivity studies were performed for the 2A25 PR rainfall algorithm. These studies were coordinated with the NASDA/EORC (Earth Observing Research Center) in Japan. The studies made use of previously measured drop size distribution data and new techniques for retrieving path integrated attenuation. For more information, contact John Kwiatkowski (johnk@tsdis.gsfc.nasa.gov).

Comparison of TRMM satellite and GV Rainfall Products

Statistical comparisons were made between TRMM satellite rainfall estimates and ground validation (GV) rainfall observations for Kwajalein, Marshall Islands; Melbourne, Florida; and Houston, Texas. This study used 4 years of TRMM data. Statistical comparisons were also made between the various TRMM global satellite rain products. For more information, contact Yimin Ji (yji@tsdis.gsfc.nasa.gov).

Storm Height Studies

TSDIS collaborated with the MIT Lincoln Labs in a study of warm rain and storm height over oceans. Contributions were made to the analysis of shallow, isolated storms in the TRMM coverage area (globally from 35 degrees north to 35 degrees south latitude). For more information, contact John Kwiatkowski (johnk@tsdis.gsfc.nasa.gov).

TRMM Data Trending

The TRMM satellite was boosted to a higher orbit in August 2001 to extend the mission life. The science team expressed an interest in monitoring the quality of the data following the boost. The scientists also wanted to determine whether to consider the pre- and post-boost data as one long data set or as two discrete datasets. To address their concerns, TSDIS produced trend plots of 250 variables. The plots are automatically updated daily and are displayed on a Web site. The trending page is located at (<http://tsdis.gsfc.nasa.gov/tsdis/Trending/trending.html>). The sample plots above show the daily mean and standard deviation for surface rain from only the raining pixels using the PR rain algorithm 2A-25. The plots cover the time period from 1 May 2001 to 5 January 2002. The dates of the boost are characterized by vertical lines. The mean rain rate after the boost (2.98 mm/hr) is greater than the mean rain rate prior to the boost (2.82 mm/hr).

In the future, the trend plots may be useful for climatological analyses and TRMM instrument validation. For more information, contact John Stout (stout@tsdis.gsfc.nasa.gov).

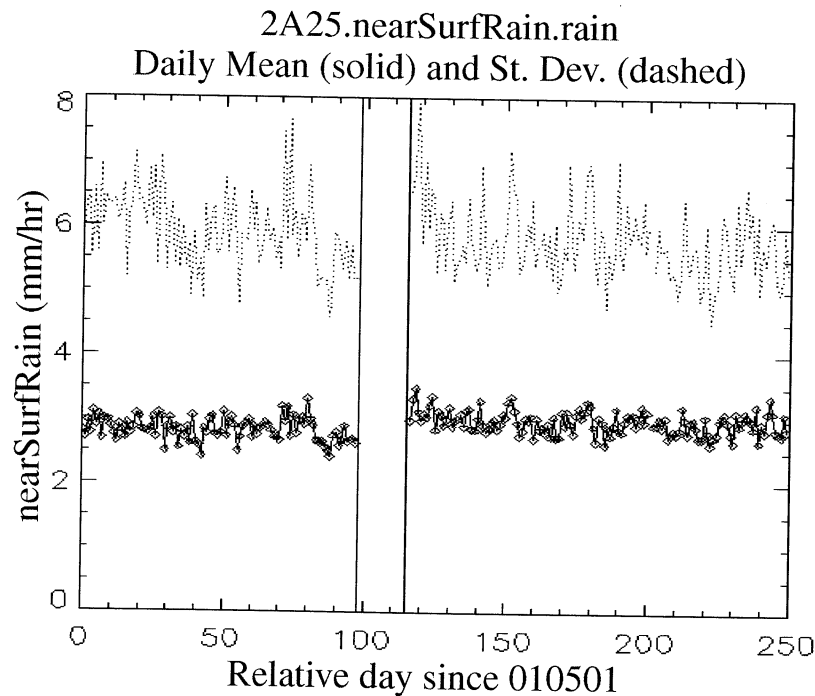


Figure 9. Trend plot of near surface rain from the PR rain algorithm (2A25). The daily mean (solid) and standard deviation (dashed) are shown. The ordinate is rain (mm/hr) and the abscissa is days since January 5, 2001.

Disdrometer Drop Size Distribution (DSD) Study

A technique is being developed to incorporate drop size distributions obtained from disdrometer measurements into the TRMM PR rain retrieval algorithm. This is being done in coordination with U.S. TRMM science team members. The primary goal of this work is to facilitate the inclusion of field campaign data into the TRMM satellite rain retrieval algorithms. For more information, contact John Kwiatkowski (johnk@tsdis.gsfc.nasa.gov).

Upgrades to the Data Processing System

Significant hardware upgrades were made to TSDIS in 2000. The processing machines were upgraded from SGI Challenge L or XL to SGI Origin 2000, and from HP K200 to HP L2000. Disk storage was more than doubled by upgrading from 2 TB of 4 GB and 9 GB SCSI disks to more than 5 TB of fully RAIDed fiber channel disks. The capacity of the Unitree MO (Magneto-Optical), DLT (Digital Linear Tape), and AIT (Advanced Intelligent Tape) libraries was upgraded from a combined capacity of 100 TB to a capacity of more than 200 TB and with twice the access speed. The NetApp (Network Appliance) servers were upgraded to their full 3 TB capacity. The TSDIS networks were also upgraded. Both the 10 Mb Ethernet and the FDDI (Fiber Data Distribution Interconnect) networks were upgraded to 100 Mb fast Ethernet networks.

The system upgrades increased the processing power and speed for data processing. In particular, the reprocessing capability has been verified as capable of processing at least 8 data days per day. This well exceeds the original system design of 2 data days per day. For more information, contact Charles Cosner (cosner@tsdis.gsfc.nasa.gov).

Improvement in Data Format Handling

It is natural for science algorithms to evolve over the course of a mission. As the mission science algorithms change, so do their data formats as parameters are added, deleted, or modified. Each time a data format is changed, information has to be manually entered in several applications in TSDIS (i.e., file specification documents, data volume estimates, I/O software, and visualization software). This is not only time consuming, but inconsistencies among the applications become possible. An improved method for handling data format changes was developed which requires that changes be entered in only one place. Software then distributes the changes to the appropriate applications. This new method improves the efficiency, accuracy, and consistency for handling data format information. For more information, contact John Stout (stout@tsdis.gsfc.nasa.gov).

6. EDUCATION and PUBLIC OUTREACH

Approximately 13% of unique hosts accessing the GCMD Web site in 2001 also accessed the GCMD's Learning Center Web pages.

GCMD staff contributed the following education presentations:

Weir, H., "Discovering Data You Can Use in Earth Science Education Through NASA's Global Change Master Directory," presented at DLESE and Digital Earth: Bridging Multidimensional Geospatial Data Resources for Educators II session, American Geophysical Union Spring Meeting, May 29–June 2, 2001. EOS. Tran. AGU, 82(20), Spring Meet. Suppl., Abstract ED22A-07, pg. S114, 2001.

Weir, H. "Using NASA's Global Change Master Directory In An Earth Science Curriculum," presented at the Strategies Which Foster Broad Use and Deployment of Earth and Space Science Informal and Formal Education Resources session at the Fall American Geophysical Union Meeting, December 2001, EOS. Tran. AGU, 82(47), Fall Meet. Suppl., Abstract ED12A-0159, pg. F232, 2001.

GCMD staff made the following presentations for public outreach:

S. Ritz, Portals Of Discovery: Customized Gateways to Discovering Earth Science Data, Presented at the American Meteorological Society, January 2001.

L. Olsen, Supporting Interagency Collaboration Through the Global Change Data and Information System (GCDIS), at American Meteorological Society, January 2001.

J. Pollack, Syntactic and Semantic Validation Within a Metadata Management System, presented at the EO/GEO Meeting, Fredericton, NB, Canada, June 2001.

S. Leicester and L. Belbin, The Virtual Antarctic Master Directory: A portal to Antarctic data sets, poster presented at the Geological Society of America, November 2001.

CD-ROMs produced by GES DISC—

- Completed testing of the external browser containing SeaWiFS images and ordering mechanism
- New set of AVHRR Pathfinder Land (PAL) 10-day continental NDVI

GES DISC prepared an exhibit for TUGIS 2001 conference, Baltimore, Maryland, describing recent developments at the DISC with respect to GIS and interoperability

GES DISC supported a joint DISC and GCMD exhibit booth in the Oceanography Americas 2001 Conference in April 2001.

GES DISC participated in SIESIP Technology Buffet session in the ASPRS 2001 Conference, held in St. Louis April 24–27, 2001.

GES DISC printed the following brochures in April, 2001—

- Data from TRMM Field Experiments at the GES DISC DAAC
- Ocean Color Data at the GES DISC DAAC, CZCS, SeaWiFS, and MODIS
- MODIS Data from the GES DISC DAAC
- TRMM Data from the GES DISC DAAC

The TSDIS Orbit Viewer was used to make images for outreach purposes and assistance was provided to organizations who wanted to make their own images from TRMM data for outreach activities. For the Breaking News section of the TRMM Home Page (<http://trmm.gsfc.nasa.gov>), images were created that advertised that the satellite was functioning fine at its new post-boost altitude.

Assistance in learning how to visualize TRMM data was provided by TSDIS to graduate students and researchers at the following institutions: University of New Mexico, the NASA Earth Science Information Partner-3 (ESIP-3) Data Center in California, National Space Development Agency–Japan (NASDA), George Mason University, Pennsylvania State University, State University of New York (SUNY), Massachusetts Institute of Technology (MIT), Germany's DKRZ, the National University of Columbia, and Florida State University.

A CD that includes TRMM data, prelicensed visualization software, and documentation was created by TSDIS. This CD is useful for outreach purposes because it is a self-contained introduction to TRMM. Over 150 copies of the CD were distributed to researchers in Egypt, Hong Kong, Japan, Australia, Germany, and across the United States. For more information, contact Owen Kelley (okelley@tsdis.gsfc.nasa.gov).

APPENDIX 1. VISITORS

Dr. Katherine Bouton, representing GOSIC, University of Delaware, visited GCMD.

Dr. Wendell Brown and Dr. Frank Bub of University of Massachusetts-Dartmouth visited GCMD.

Dr. Robert Groman of Woods Hole Oceanographic Institute and Hester Willson from the UK visited GCMD for support of GLOBEC.

Akihiro Matsushima, Tomomi Nio, Takeshi Sasada, Akiyo Yatagi, and Kazu Yoshida, all of NASDA/EOC, visited TSDIS on June 14, 2001.

APPENDIX 2. SEMINARS, MEETINGS AND WORKSHOPS ORGANIZED BY GCDC

GCMD hosted the Global Change Master Directory Science User Working Group at NASA/GSFC, April 17–18, 2001.

GCMD cosponsored the USGCRP/DIMG Workshop “Gaining Knowledge from Environmental Data,” Ft. Collins, Colo., May 1–3, 2001.

GES DISC/DAAC organized, sponsored, and hosted the GES DISC/DAAC User Working Group Meeting, at GSFC, Greenbelt, Maryland, June 14–15, 2001

APPENDIX 3. PUBLICATIONS

- O. A. Kelley, J. Stout, and M. Kafatos, "Content-based Browsing of Data from the Tropical Rainfall Measuring Mission (TRMM)," Proceedings of the 13th International Conference on Scientific and Statistical Database Management (SSDBM), pp. 270-273, Fairfax, Virginia, July 18, 2001.
- J. Koziana, S. Ahmad, G. Leptoukh, A.K. Sharma and G. Serafino, "MODIS Atmospheric Data Products at the Goddard Earth Sciences DAAC," Proceedings of IGARSS 2001 Symposium, July 9-13, Sydney, Australia, IV: 1708-1710, 2001.
- J. Koziana, A. Savtchenko, G. Leptoukh, A. Sharma and G. Serafino, "Ocean Data from MODIS at the NASA Goddard Earth Sciences DAAC," Proceedings of IGARSS 2001 Symposium, July 9-13, Sydney, Australia, IV: 1753-1755, 2001.
- J. Kwiatkowski and J. Stout, "Tropical Rainfall Measuring Mission Algorithm Consistency Studies," Proceedings of IEEE 2001 International Geoscience and Remote Sensing Symposium, pp. 673-675, Sydney, Australia, July 9-13, 2001.
- G. Leptoukh, S. Ahmad, P. Eaton, J. Koziana, D. Ouzounov, A. Savtchenko, G. Serafino, A. Sharma, M. Sikder and B. Zhou, "MODIS Data Ingest, Processing, Archiving and Distribution at the Goddard Earth Sciences DAAC," Proceedings of IGARSS 2001 Symposium, July 9-13, Sydney, Australia, V: 2286-2288, 2001.
- C. Lynnes and R. Mack, "Knowledge Discovery in Databases (KDD) Services at the Goddard Earth Sciences Distributed Active Archive Center," a chapter in the book Data Mining for Scientific Applications, R. Grossman et al., (Eds.), pp 165-181, 2001.
- C. Lynnes, B. Vollmer, S. Berrick, R. Mack, L. Pham, and B. Zhou, "Simple, Scalable, Script-Based Science Processor (S4P)," Proceedings of IGARSS 2001 Symposium, July 9-13, Sydney, Australia, III: 1465-1467, 2001.
- R. Meneghini, T. Iguchi, T. Kozu, et. al., 2000: "Use of the Surface Reference Technique for Path Attenuation Estimates from the TRMM Precipitation Radar," *J. Appl. Met.* Vol. 39, No. 12, pp. 2053-2070.
- R. Meneghini, J. Jones, T. Iguchi, K. Okamoto and J. Kwiatkowski, 2001: "Statistical Methods of Estimating Average Rainfall over Large Space-Time Scales Using Data From the TRMM Precipitation Radar," *J. Appl. Met.* Vol. 40, No. 3, pp. 568-585.
- J. Pollack, "An Interactive, Web-based Approach to Metadata Authoring," Proceedings of the Association of American Geographers Conference, February 27-Mar 2, 2001.
- J. Stout and R. Meneghini, "Comparison of Instantaneous TMI and PR Rainfall Data from the TRMM Satellite," Proceedings of the 11th Conference on Satellite Meteorology and Oceanography, pp. 659-661, Madison, Wisconsin, Oct. 15-18, 2001.
- Y. Ji and E. Stocker, "Seasonal and Interannual Variations of Global Fire and Aerosol From Satellite Observations," Proceedings of IGARRS 2001 Symposium, Sydney, Australia, July 9-13, 2001.

APPENDIX 4. AWARDS and HONORS

- Quarterly Customer Service Excellence Award — awarded to the GES DISC Data Support and Operations Groups
- Quarterly Outstanding Teamwork Award — awarded to the GES DISC Engineering and Science Integration Groups
- Excellence in Information Science And Technology Award, GSFC's highest information science award, coawarded to Chris Lynnes
- Best of the Best Customer Service Excellence Award — awarded to the GES DISC Data Support and Operations Groups

APPENDIX 5. ACRONYMS

ACE-Asia	Asian Pacific Regional Aerosol Characterization Experiment
AIRS	Atmospheric Infrared Sounder
AIT	Advanced Intelligent Tape
ATOVS	Advanced TIROS Operational Vertical Sounder
AVHRR	Advanced Very High-Resolution Radiometer
CEOS IDN	Committee on Earth Observation Satellites' International Directory Network
CO-OP	Products and Services Cooperative
CSG	Computing Systems Group
CSI	Coincident Subsampled Intermediate
CVS	Concurrent Versioning System
DAAC	Distributed Active Archive Center
DAO	Data Assimilation Office
DAS	Data Assimilation System
DIF	Directory Interchange Format
DISC	Data and Information Systems Center
DKRZ	Deutsche Klimarechenzentrum
DLT	Digital Linear Tape
DODS	Distributed Oceanographic Data System
DSD	Drop Size Distribution
DST	Data Support Team
EC/JRC	European Commission Joint Research Center
ECHO	EOSDIS Clearinghouse
ECS	EOSDIS Core System
EDG	EOSDIS Data Gateway
EOC	Earth Observation Center (Japan)
EORC	Earth Observation Research Center (Japan)
EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
ESE	Earth Sciences Enterprise
ESIP	Earth Science Information Partner
FDDI	Fiber Data Distribution Interconnect
FGDC	Federal Geographic Data Committee
FvDAS	Finite Volume Data Assimilation System
GB	Gigabyte
GCDC	Global Change Data Center
GCM	General Circulation Model
GCMD	Global Change Master Directory
GCOS	Global Climate Observing System
GEOS	Goddard Earth Observing System
GES	Goddard Earth Sciences
GIS	Geographic Information Systems
GLOBEC	Global Ocean Ecosystems Dynamics program

ACRONYMS

GMS	Geostationary Meteorological Satellite
GOES	Geostationary Operational Environmental Satellites
GOFC	Global Observation of Forest Cover
GOOS	Global Ocean Observing System
GOSIC	Global Observing System Information Center
GPM	Global Precipitation Mission
GSFC	Goddard Space Flight Center
GTOS	Global Terrestrial Observing System
GV	Ground Validation
HP	Hewlett Packard
IR	Infrared
IT	Information Technology
ITE	Integration and Test Environment
JCADM	Joint Committee on Antarctic Data Management
KDD	Knowledge Discovery in Databases
LDA	Local Database Agent
LUT	Look Up Table
MIT	Massachusetts Institute of Technology
MO	Magneto-optical
MOC	Mission Operations Center
MODAPS	MODIS Adaptive Processing System
MODIS	Moderate Resolution Imaging Spectroradiometer
MOSS	Mission Operations Science System
NAS	NASA Advanced Supercomputing Division
NASDA	National Space Development Agency (Japan)
NCCS	NASA Center for Computational Sciences
NCEP	National Centers for Environmental Prediction
NESDIS	National Environmental Satellite Data and Information Service
NetApp	Network Appliance
NOAA	National Oceanic and Atmospheric Administration
NPP	NPOESS Preparatory Project
NSDI	National Spatial Data Infrastructure
OASIS	On-line Analysis Software
Open-API	Open - Applications Programming Interface
PAL	Pathfinder Land
PC	Personal Computer
PGE	Product Generation Executable
PR	Precipitation Radar
PSAS	Physical-space Statistical Analysis System
PSC	Products and Services Cooperative
RAID	Redundant Array of Inexpensive Disks
RMI	Remote Method Invocation
RSIP	Remote Sensing Information Partner
RSMAS	Rosenstiel School of Marine and Atmospheric Science

S4P	Simple Scalable Script-based Science Processor
SCSI	Small Computer System Interface
SDPF	Sensor Data Processing Facility
SeaWiFS	Sea-viewing Wide Field-of-view Sensor
SERF	Services Entry Resource File
SGI	Silicon Graphics Incorporated
SSM/I	Special Sensor Microwave/Imager
SUNY	State University of New York
SW	software
TB	Terabyte
TMI	TRMM Microwave Imager
TRACE-P	Transport and Chemical Evolution over the Pacific
TRMM	Tropical Rainfall Measuring Mission
TSDIS	TRMM Science Data and Information System
UCAR	University Center for Atmospheric Research
ULDB	Ultra Long Duration Balloon
UNM	University of New Mexico
UWG	User Working Group
V0	Version 0
V1	Version 1
V2	Version 2
VDD	Version Description Document
VIRS	Visible and Infrared Scanner
WDCs	World Data Centers
WHOM	Web-based Hierarchical Ordering Mechanism
XML	Extended Mark-up Language
ZOPE	Zen of Object Publishing Enterprise

